Space Weather Technical Forecast

Issued on Friday, 16 September 2022 at 13:28 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

---

Space Weather Forecast Headline: Chance of a G1/Minor geomagnetic storm. Chance of R1/R2, but risk falling later in weekend. Slight chance of a CME arriving at Earth later in the period.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was High over the past 24 hours, with an M7.9 class flare, peaking at 16/0949 UTC, which appears to have originated from AR3098 located on the west limb. Subsequently, this has produced an R2 Radio Blackout. We are awaiting coronagraph imagery for a potential CME from this event.

Meanwhile, a long duration C-class flare which occurred earlier on the 15th was associated with a filament eruption in the southwest quadrant, which subsequently produced a CME. Given its location, there is the potential for an Earth-directed component, with further analysis on-going to ascertain this possibility.

There are currently four sunspot regions on the visible disc, with AR3098 the largest and most complex, appearing as an Esc/Beta-Gamma. However, this region is becoming more difficult to analyse due to its location on the west limb and the foreshortening effect. There are two other groups of note, both with relatively unpopulated centres, which gives lower probabilities of flares. AR3100 has seen its trailing spots continuing to fade. However, AR3102 has recently seen its trailing spots re-emerging. AR3103 continues to grow in the period, becoming a Cri/beta.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR and ACE at L1, was at slow ambient levels throughout, generally close to 350 km/s, after the previous day's CME arrival. The solar wind density was initially average to below average, before fluctuating between average and above average, with a peak of 16ppcc at 16/0611 UTC. The IMF started the period peaking at 14 nT, with a gradual decline to end the period near 5 nT. The north-south component of the magnetic field was positive throughout, with a steady decline towards negative values by the end of the period. The Phi angle was positive initially, then switched to become negative after approximately 15/1317 UTC. Geomagnetic activity was Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16, was at background levels initially, becoming slightly elevated towards the end of the period, following the recent M7.9 flare from AR3098 on the west limb.
Electron flux was Low to Moderate, peaking at 355 pfu at 15/2055 UTC. The corresponding 24-hour electron fluence was initially above the Active threshold, (1e8 integrated pfu), but then quickly declined. At 16/0001UTC the observed fluence value was 1.1e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to remain predominately at Low levels, with a further chance of M-Class flares, today and tomorrow. Thereafter solar activity is expected to decline, as AR3098 rotates off the Earth-facing disc. No notable regions are due over the limb to

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

compensate.

Solar Wind / Geomagnetic Activity: After starting at background speeds the solar wind is expected to become enhanced later today or early tomorrow, due to the arrival of a HSS from coronal hole 23, shortly followed by a weaker HSS from smaller CH24. This means the geomagnetic activity will be Quiet to Unsettled (Kp 1-3) today, then increasing Unsettled to Active (Kp 3-4) overnight with a chance of a G1/Minor geomagnetic storm (Kp 5).

From day 3 (18th) geomagnetic activity is excepted to decline to predominately Quiet levels (Kp 0-2). However, this aspect of the forecast may change depending on the results from the pending analysis of the CME, which was associated with a filament eruption, which lifted off the southwest limb earlier on the 15th. This has the potential to be Earth-directed, which would increase geomagnetic activity during the latter part of the forecast period.

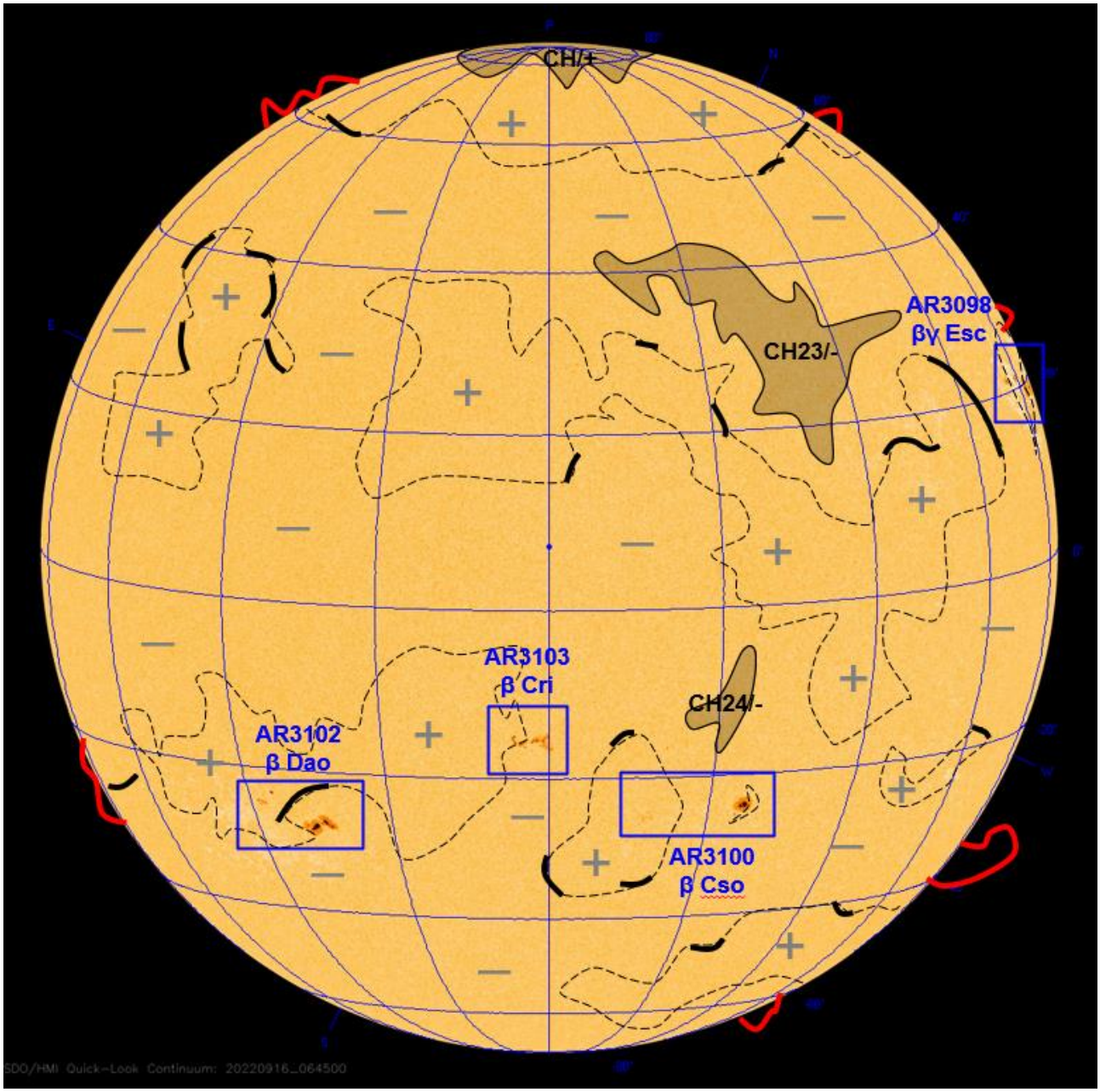
Energetic Particles / Solar Radiation: There is a Slight Chance of S1, mainly today and tomorrow, before AR3098 rotates off the visible disc.

The high energy electron flux (greater than 2MeV) is expected to start at background to moderate levels, then probably increasing to High levels after the arrival of the HSS, with this possible from day 3 (18th). The corresponding electron fluence is expected to increase later in the period, and is likely to reach Active levels (1e8 integrated pfu) during day 4 (19th).

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Figure 1. Solar Analysis Valid 16/0645 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Geomagnetic Storms:

After starting at background speeds the solar wind is expected to become enhanced later today (16th) or early tomorrow (17th), due to the arrival of a HSS from coronal hole 23 and then a weaker HSS from CH24 tomorrow. CH23 feature is a recurring coronal hole, which on the past rotation produced a G1/Minor storm with wind speeds of 650-700 km/s, although the HSS arrived quicker.

Geomagnetic activity is expected to be Quiet to Unsettled (Kp 1-3) today, then increasing Unsettled to Active (Kp 3-4) overnight with a chance of a G1/Minor geomagnetic storm (Kp 5). From day 3 (18th) geomagnetic activity is excepted to decline to Quiet levels (Kp 0-2).

However, the CME from the filament eruption on the 15th may have an Earth directed component, and is most likely to arrive on day 3 (18th). If this occurs then geomagnetic activity is likely to remain Unsettled to Active with a chance of a G1/Minor geomagnetic storm.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	40	40	30	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

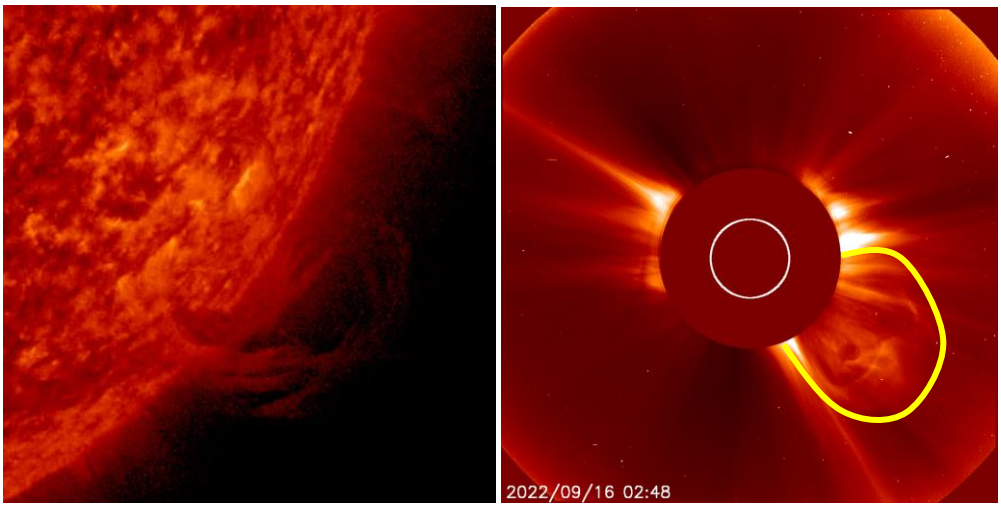
Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil – However, the CME from the filament eruption on the 15th may have an Earth directed component, which requires further analysis.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Figure 2: SDO 304 imagery shows the filament eruption lifting off the southwest limb, following a long durartion C-class flare earlier on the 15th, with an associated CME seen in LASCO C2 imagery. This is currently under analysis for any potential Earth-directed component.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Radio Blackouts - X-Ray Flares:
There are currently four sunspot regions on the visible disc. AR3098 remains the largest and most complex, appearing as an Esc/Beta-Gamma. However, analysis is becoming more difficult as the region approaches the west limb due to the foreshortening effect.

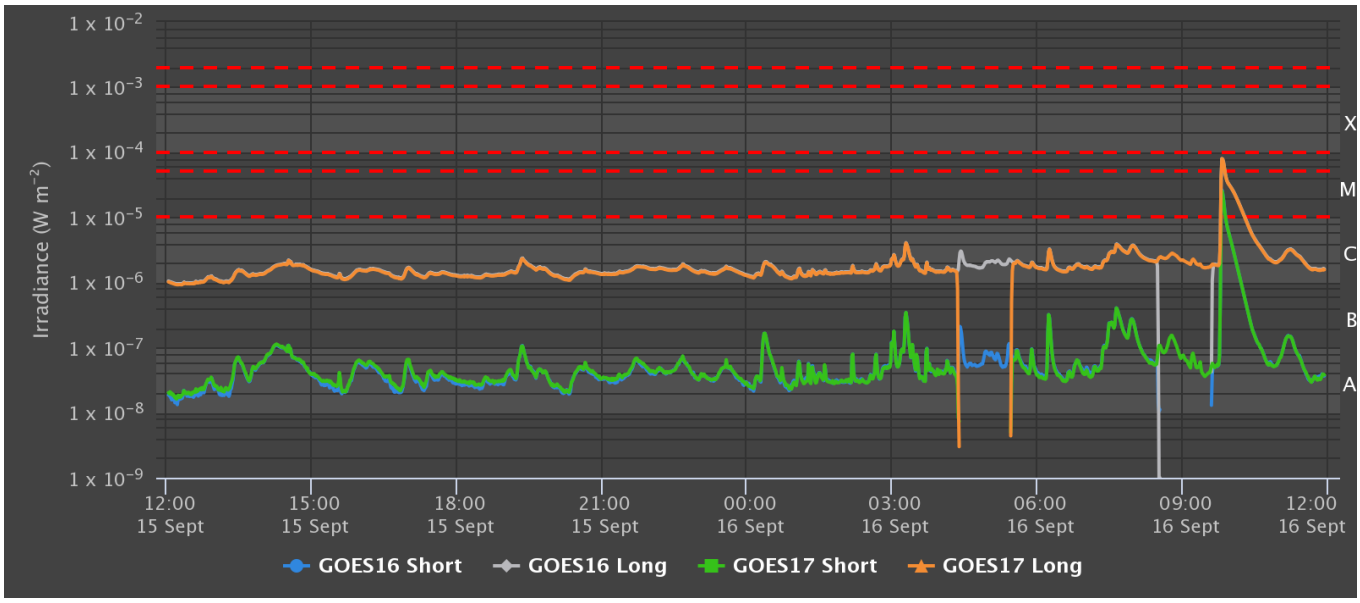
AR3098 has recently produced an M7.9 flare, peaking at 16/0949 UTC. Subsequently, this produced an R2 Radio Blackout.

AR3100 has simplified, with the trailing spots losing their penumbra, with the trailing spots now barely visible. The trailing spots of AR3102 have recently re-emerged after fading on previous analysis. AR3103 has continued to develop, with more intermediate spots emerging.

Solar activity is expected to remain predominantly at Low levels, with a chance of further M-Class flares, today and tomorrow. Thereafter solar activity is expected to decline, as AR3098 rotates off the Earth-facing disc. No notable regions are due to rotate onto the visible disc to compensate.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	40	20	15	5
Very Active	R3 to R5 X Class	No	5	5	1	1

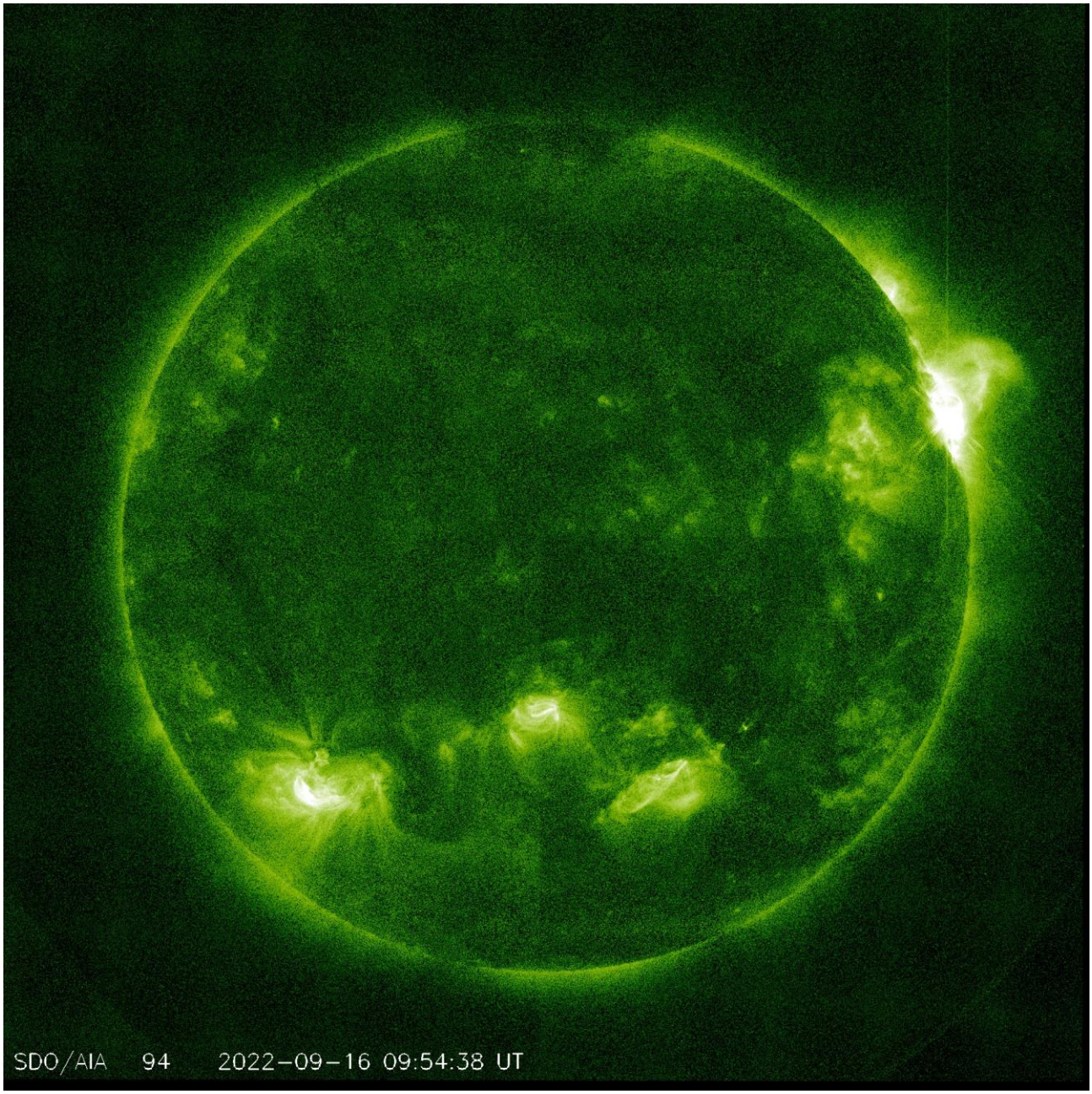
Figure 3: X-Ray flares – shows the recent M7.9 flare from AR3098 on the west limb (see SDO 94 imagery below).



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Space Weather Technical Forecast



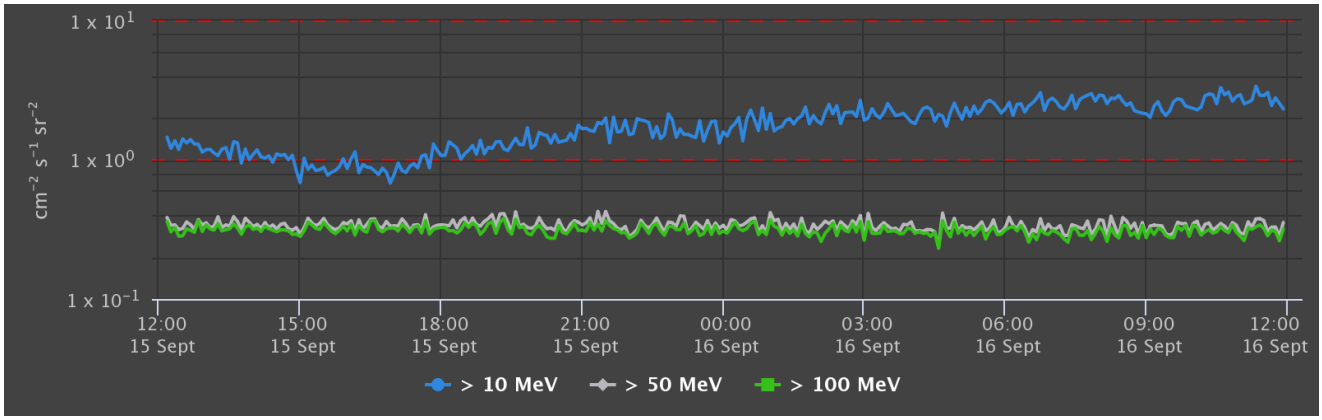
Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (greater than 10MeV) is currently near background levels. There is a Slight Chance of S1, mainly today and tomorrow, before AR3098 rotates off the visible disc.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	5	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: GOES-16 Proton Flux – which has been slightly elevated due to the recent solar flare activity from AR3098 on the west limb.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

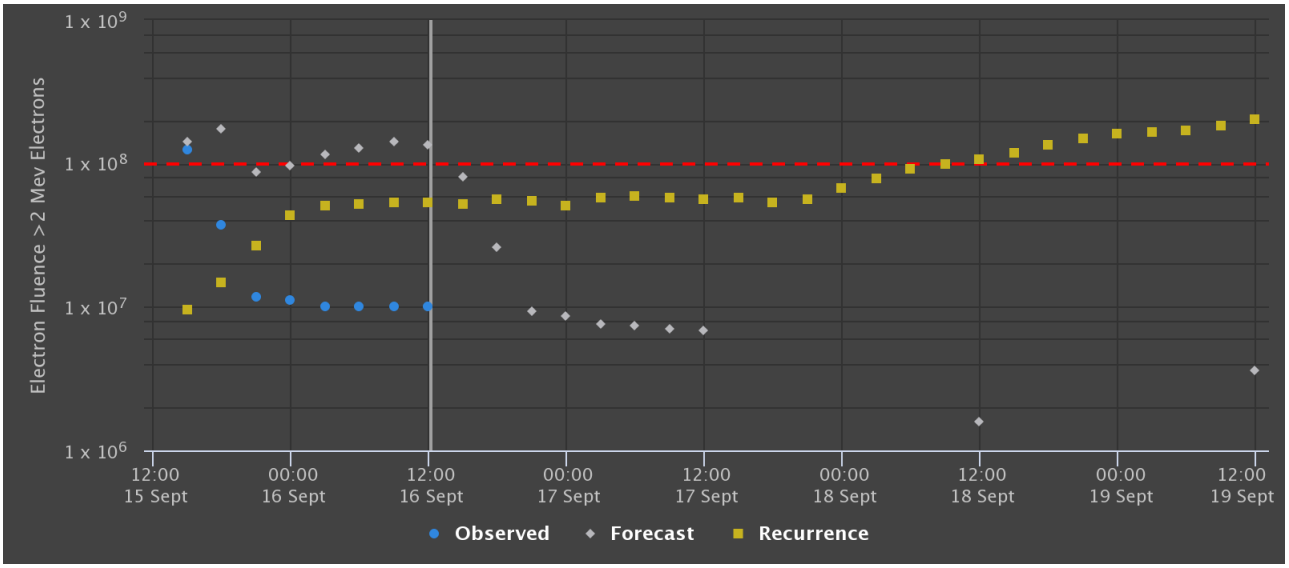
High Energy Electrons Event (≥ 2MeV):
The high energy electron flux (greater than 2MeV) is expected to start at background to moderate levels, then probably increasing to High levels after the arrival of the HSS, with this possible from day 3 (18th), which depends on the CME from a filament eruption on the 15th arrives at Earth, or not - pending analysis.

The corresponding electron fluence is expected to increase later in the period, and is likely to reach Active levels (1e8 integrated pfu) during day 4 (19th), which happened on the previous rotation.

The Met Office REFM model is considered to be offering poor guidance initially, with a continued downward trend in the fluence expected. Later in the period the forecast upwards trend is currently accepted.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	20	20	40	60
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: REFM electron fluence - observation, forecast and recurrence.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.